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In the Spirit of the Silk Road

—An Introduction of Wu Wen-Tsun's Silk Road Program on
the Mathematical and Astronomical Transmission in the History

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Abstract

The Silk Road had been a cultural tie between East and West in history. Although it was deserted after the Yuan Dynasty, yet its spirit—knowledge exchange and cultural mergence has been and will always be an important lever of the progress of mathematics and of science and technology in general. To investigate into the related aspects and problems about mathematical and astronomical exchanges among the Asian areas as well as between Asian and European countries in ancient and medieval times and to display historical roots of diverse civilizations of modern mathematics, the Wu Wen-Tsun's Silk Road Program on the Mathematical and Astronomical Transmission in the History was established in August 2001 by sponsorship of Wu Wen-Tsun's Silk Road Foundation. This talk presents the principal ideas of the Silk Road Program, its sub-programs and their recent advances. The current situation of the international cooperation in the program is introduced, and finally the further development is looked ahead.

At the International Congress of mathematicians 2002, Professor Wu Wen-Tsun, as Chairman of the Congress, addressed for the opening ceremony and the following is a quotation from his speech:

Modern mathematics has historical roots of diverse civilizations. ...Today we have railways, airlines and even information highway instead of the Silk Road, the spirit of Silk Road—knowledge exchanges and cultural mergence ought to be greatly carried forward.

To carry forward the spirit of Silk Road, right one year before the ICM-2002, Professor Wu contributed 1 million CY, which was taken from his award as the highest National Prize for Science and Technology, to form the Silk Road Foundation to promote researches on mathematical and astronomical exchanges between China and Middle Asia as well as other Asian countries in ancient and medieval times. This paper presents the principal ideas of the Silk Road Foundation program, its sub-programs and recent advances, the current situation of the international cooperation in the program and the plan for the further development.

I. Principal ideas

Over thousand years from 2nd century BC, along the Silk Road, technical

innovation, scientific knowledge, art and religions were transmitted between East and the West and different cultures were impacted each other. In particular, the meeting of mathematics of Greek type and the Eastern mathematics promoted greatly the arising of modern mathematics.

The ancient Chinese mathematics was very different from Greek type of math. It's characterized by the major activities of equation solving and algorithmic creating, while the Greek math is characterized by the major activities of deductive theorem-proving. In fact, the researches on the history of mathematics by Prof. Wu since the mid-seventies of the last century strongly suggest two main lines of mathematics development:

Deductive(Greek) line—theorem-proving

Algorithmic(Oriental) line—Equation solving and algorithmic creating

Both are important levers of progress of mathematics, and the parts they played in development of mathematics cannot be considered interchangeable. As far as arising of the modern mathematics, one may find that even stronger algorithmic and mechanical tendency was embodied in, its two key events—the establishments of both the calculus and analytic geometry were perhaps among the most convincing examples of that (For the case of Calculus see Rybnikov, K.A. *On the Role of Algorithms in the History of Mathematical Analysis*, Actes du VIII Congres International d'Histoire des Sciences, vol. I. Firenze & Paris, 1958; and Prof. Wu and I myself investigated into the case of analytic Geometry, see Wu Wen-Tsun *Mechanization of Mathematics*, Science Press & Kluwer).

Contrast with the Greek mathematics, however, the Oriental tradition in mathematics received no enough exploration so far as the aspect of its relation to the arising of modern science. As regards exchanges between East and the West, the transmission to Europe of Chinese mathematics and astronomy has been in fog, in spite of the fact that we know the clear route along which camel teams transmitted silk and chinaware to the Middle East and eventually to Europe in the whole Middle Age.

The establishment of Silk Road Foundation is right an effort to encourage and support potential young Chinese scholars to work on the mathematical and astronomical exchanges between China and other Asian countries in ancient and medieval times and clarify the real situation of the transmission along the Silk Road, to explore Oriental heritage of mathematics and astronomy and their role in arising of the modern science, to promote international cooperation in this regard; and through those activities to train and bring up young experts in the field.

To materialize the principal ideas of Silk Road Foundation, Prof. Wu appointed an academic committee. The Committee consists of 6 members, among them are Amier(Xinjiang University), Li Di(Inner-Mongolia Normal University), LI Wenlin(CAS), Liu Dun(CAS), Liu Zhuojun(CAS) and Shen

Kangshen(Zhejiang University). LI Wenlin assumes the responsibility of the program coordinator, and WU WenTsun himself is the general adviser of the committee. The committee is responsible for

- (i) Selecting appropriate young scholars to develop researches on mathematical and astronomical exchanges along the Silk Road, and supporting their direct investigation, if necessary, into the Middle Asia area and into Japan and Korea;
- (ii) Reviewing proposals of program submitted by the selected scholars;
- (iii) Evaluating working reports of the approved programs and sponsoring publication of research results;
- (iv) Organizing proper academic conferences including international colloquium, and pushing forward international cooperation in the silk road program.

II. Advances of sub-programs

First, one remark is that the term "Silk Road" is to be understood here in its general sense, that means it included three routs

West route Changan(Xi'an)-middle Asia-Europe

East route Changan-Japan and Korean Peninsula

South route Changan-middle Asia-South Asia& South-East Asia

Therefore the Silk Road Foundation supported in total six sub-programs up to now:

- (1) *Investigating into Source Material in Mathematics and Astronomy in Middle Asia*
- (2) *Chinese Translation of Fibonacci's Liber Abaci with Comparative Comments*
- (3) *Comparative Studies in Mathematics of Medieval China and Islam*
- (4) *Researches in the Transmission and Influence of Chinese Classics of Mathematics in Japan*
- (5) *Investigating into Historical Material in Transmission of the Traditional Chinese Mathematics in Japan*
- (6) *Researching in Mathematical Exchanges between China and Korea*

The following are the advances made by each sub-program.

West Route Programs

◇Xinjiang University(Ilihamu&Amier) *Investigating into Source Material in Mathematics and Astronomy in Middle Asia*

Arabic literatures are rich resources which may provide leads for uncovering the real situation of the transmission of mathematics and astronomy along the Silk Road. To Chinese scholars the difficulties have been in language problems and financial aspect. Wu Wen-Tsun's Silk Road foundation program offers opportunity and impelling to overcome such difficulties and develop researches in this context.

The task of Xinjiang group is to investigate into the source material in mathematics and astronomy in Middle Asia area. The group is of the geographic advantage, and two members from Xinjiang University are able

to manage reading of Arabic texts. Till moment, they have investigated over 1000 copies of sources from libraries located in Uzbekistan and Kazakhstan including famous historical city Samarkand's library, and brought back 2000 photos and 17 books of the following authors

al-Khowarizmi (783—850)

al-Farabi (870-950)

Iben Sina (980—1037)

al-Biruni (973—1048)

al-Kashi(1380—1429)

Ulugh Beg (1397—1449)

In collaboration with researchers of Uzbek Academy of Science, the group has completed Chinese translations of two works by al-Khowarizmi and is doing study in Al- Kashi and his representative work *The Key to Arithmetic* and translating the work into Chinese with comparative commentaries. Researches on Ulugh Beg's astronomical work has also been done which shows interesting interaction in astronomy and calendar making between China and Islamic World (A talk on Ulugh Beg was given by Prof. Amier at the Xi'an conference in the last August).

◇Shanghai Jiaotong University(Ji Zhigang) *Chinese Translation of Fibonacci's Liber Abaci with Comparative Comments*

" Fibonacci was the greatest Christian mathematician of the Middle Ages, and the mathematical renaissance in the West may be date from him." (George Sarton, Introduction to the History of Science, vol.II, p611).

Fibonacci 's most famous masterpiece *Liber Abaci* not only introduced the rules for computing with the new Hindu-Arabic numerals, but also contained numerous problems of various sorts in such practical topics as measurement, calculation of profits, currency conversions, which appeared in the form of mixture problems, motion problems, container problems. The sources for the *Liber Abaci* were largely in the Islamic world, which Leonardo visited during many journeys, but the Silk Road connected those sources to China.

In fact, Louis C. Karpinski had already noticed that. In *The History of Arithmetic*, Karpinski pointed: "In any event, however, the Chinese had a real gift for the Hindus and Arabs. The oriental source of many problems which appeared in Europe in 1202 in Leonard of Pisa's voluminous works are given by Leonard, but frequently precisely the same series of numbers, so that the oriental origin is evident. These problems were taken over by Italian arithmeticians and then from them by other Europeans."

Fibonacci and his *Liber Abaci* is therefore significant for understanding transmission of mathematics knowledge between China and Europe in Middle Age. However, there had been only some fragment pieces of *Liber Abaci* appearing in the general history of mathematics works and some source book available for Chinese historians of mathematics. The task of

the group in Shanghai Jiaotong University is to make comparative study between Chinese mathematical Classics and the mathematics in the Fibonacci's *Liber Abaci* through investigating into the book as comprehensively as possible.

As the first step, the *Liber Abaci* has been translated into Chinese by the group. In the same time, intensive reading led some comparative commentaries of interest about, for example, solution of cubic numerical equations, the method elchataym, the fraction addition and subtraction, problems such as a man buys birds, two ships meet, a vat has four holes at the bottom, five men bought a horse, etc. We believe that all those will throw light on the puzzle to China historians of mathematics how the ancient Chinese mathematics were taken into Arab and then introduced to the Latin West.

◇ Liaoning Normal University(Du Ruizhi) *Comparative Studies in Mathematics of Medieval China and Islam*

Great deal of researches on the Islamic mathematics and astronomy has been done by Russian scholars, which are helpful for our research program on the mathematical and astronomical exchanges between China and Middle East. Based on the Russian materials the Liaoning group investigated the situation of Arabic mathematics literatures kept in leading research institutions and libraries in the world, and some comparative studies in mathematics of Medieval China and Islam have been made by the group, especially about Al-Samaw'al(1125-1174) and his *Arithmetic*.

East Route Programs

China, Korea and Japan constitute an active triangle of mathematical and astronomical exchanges in ancient and Medieval times. According to the historical literatures, a number of Chinese mathematical works had been used as text books both in Japan and in Korea, among them were Nine Chapters, and in particular the 缀术(Method of Mending) by famous mathematician Zu Chongzhi in the fifth century. It is known that some mathematical classics, which were long lost in China itself, had been rediscovered in Japan or Korea. That endows our East route programs with significance.

◇ Tsinghua University(Feng Lishen) *Researches in the Transmission and Influence of Chinese Classics of Mathematics in Japan*

◇ Tianjin Normal University(Xu Zelin) *Investigating into Historical Material in Transmission of the Traditional Chinese Mathematics in Japan*

◇ Inner-Mongolia Normal University(Guo Shirong) *Researching in Mathematical Exchanges between China and Korea*

Above three sub-programs are all in the category of "East route", but the focuses are different. Tsinghua group mainly make investigation into the transmission of Chinese mathematical classics, while Tianjin group concentrate more on the comparative studies in mathematical works in

Edo period. Three groups made thorough investigations in extant Chinese mathematical classics in various libraries in Japan and South Korea such as

东京大学图书馆 Tokyo University
 日本学士院 The Japan Academy
 日本国会图书馆 National Diet Library
 宫内厅书陵部 Kunaicho Syoreibu
 东京理科大学 Tokyo University of Science
 早稻田大学 Waseda University
 庆应义塾大学 Keio University
 京都大学 Kyoto University
 东北大学 Tohoku University
 同志社大学 Doshisha University

奎章阁图书馆
 藏书阁图书馆
 延世大学 Yonsei University
 首尔大学 Seoul National University
 汉阳大学 Hanyang University
 高丽大学 Korea University
 梨花女子大学 Ewha Women's University

They cooperated to edit a comprehensive catalogue which has been completed and includes 2000 items kept in Japanese libraries and 100 items kept in South Korean libraries. I believe that for the present this is the most complete information about the Chinese mathematical classics transmitted to Japan and Korean Peninsula, and from it one may find some rare books or even unique edition which has never been known in China before, e.g.

- ◇ New transcript of 《杨辉算法》 in Yonsei University Library, Korea, which is different from 1433 庆州府 edition with some handwriting annotations on top space. (fig.1)
- ◇ 《海岛算经图说》 (Illustrated transcript of Liu Hui's 《海岛算经》 by late Edo scholar)
- ◇ 《句股弦度图说》 (Illustrated transcript of mathematical part of 李之藻 《浑盖通宪图说》, by early Edo scholar 新井白石, in Tokyo University). (fig.2)

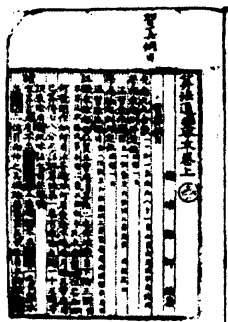


fig.1

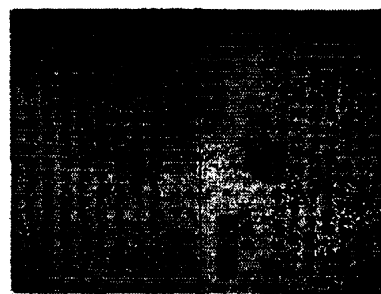


fig.2

On base of the source investigation, some Interesting work has been

or is being done, and the following are several examples.

- ◇ A research in the situation of the transmission of Zu Chongzhi's work of mathematics and calendars in Japan (by Feng Lishen);
- ◇ A comparative study in algorithms created by Seki and Takebe (by Xu Zelin);
- ◇ A monograph: *On the Transmission and Influence of Chinese Classics of Mathematics in Korean Peninsula* (by Guo Shirong);
- ◇ A monograph: *A History of Mathematical Exchanges between China and Japan*. (by Feng Lishen)

III. International cooperation

(i) Academic Exchange Visits

Supported by the Silk Road Foundation, five scholars, who are responsible respectively for one of sub-programs of the Silk Road Program, have paid academic visits to Uzbekistan, South Korea and Japan and built up cooperative relationship with colleagues in the Academy of Sciences of the Republic of Uzbekistan, Yonsei University of Seoul, Tokyo University, and so on regarding the Silk Road Program.

The Silk Road Program has also invited international guests from Japan, France, India, Iran and so on to visit China for participating related conferences and giving lectures on related topics.

(ii) Organization of International Conference

◇ XXII ICHS' Session: ALONG THE SILK ROAD

LI Wenlin (China), QU Anjing (China), and Benno van Dalen (Germany/Netherlands) co-organized a session entitled "Along the Silk Road: Mathematical and Astronomical Exchanges between East and West in Ancient and Medieval Times." This session took place on 28 July at the Academy of Mathematics and Systems Science of the Chinese Academy of Science. Its program opened with an address by Professor WU Wen-Tsun that was followed by 8 talks:

Ji Zhigang (China): "Needham's 19(j) and Fibonacci's *Liber abaci*"

Francois Charette (Germany-America): "Patronage and Science in Central Asia around 1000 CE: A Reassessment of al-Buruni's Formative Years"

Saeed Hashemi (Iran): "Connection of Old and New Mathematics on Works of Islamic Mathematicians on the Silk Way"

Ilham Yusup (China): "Some Studies on Al-Kashi's *the Key to Arithmetic*"

KOMATSU Hikosaburo (Japan): "Zhu Shijie, the Teacher of Seki and Takebe"

Jean-Claude Martzloff (France): "The Diffusion of Astronomical Parameters from Huihui Li to Japan"

B. S. Yadav (India): "Filling in the Gaps: Indo_Chinese Exchanges in Mathematics"

QU Anjing (China): "Thought But Not To Speak Out: A Scientific Tradition in Old China"

More than 80 scholars from 10 countries participated the session. The session was followed immediately by a conference on the same subject

held in Xi'an.

◇THE 1st.INTERNATIONAL CONFERENCE ON HISTORY OF EXACT SCIENCES ALONG THE SILK ROAD(July 31 - August 3, 2005,Northwest University, Xi'an)

Professor Wu Wen-Tsun was the Chairman of the conference, and Professor Yano Michio from Kyoto took the chair of the Academic Committee.

About 60 scholars from the U.K.,U.S., France, Germany, Canada, Italy, Japan. India, Egypt and China participated the conference and contributed more than 40 papers, which dealt with from multi-view points relative topics including the mathematical and astronomical exchanges and interaction between China and Islamic countries along the silk road in ancient and medieval times; The impact of such exchanges and interaction to the Europe in Renaissance; Mathematical exchanges between China and the West in the 16-17 century; Ancient Chinese calendars and their influence on the South-East Asia, and so on. In particular there were 5 contributions from Japanese scholars:

Hikosaburo KOMATSU (小松彦三郎) .*Possible influence of Chinese mathematics to Descartes and of Archimedes to Seki.*

Michio YANO (矢野道雄) . *Transmission of Astrology along Silk Road.*

Shigeru NAKAYAMA (中山茂) .*Completion and publication of Shoushili research.*

Yukio OHASHI (大桥由纪夫) .*Mainland South-East Asia as a crossroad of Chinese astronomy and Indian astronomy.*

Masanori HIRAI (平井正则) .*Influence of European Astronomy to star Charts in Edo Period,Japan.*

IV. Prospect

(i) Research Programs

The above mentioned 6 sub-programs will be continued, the emphasis in the next step, however, will be more on the mathematical exchanges between China and Middle East. A research team of two or three talent young scholars for investigating in Islamic sources more in depth is being organized, which will cooperate with historians of mathematics from the Middle East area. Through that we hope to have enable young experts in this subject just as we did in the programs on the East route.

(ii) Publications

Except research papers and monographs, from 2006 we shall publish in succession some classic sources translated into Chinese which are significant for better understanding the real situation of the mathematical and astronomical exchanges along the Silk Road:

*Fibonacci' s *Liber abaci* (From L. E. Sigler' s English translation, check against the Latin edition)

*Al-Khwarizmi' s *Algorithm* (From Ashraf' s Uzbek version, check against the Latin manuscript) and

Algebra(Use three versions:

English version, by Frederic Rosen, new edition with
Commentaries;

Uzbek version, by Ashraf Ahmad , Science Press of
Uzbekistan, Tashkent, 1983;

Persian version , by Husayn Khadiv Jam,
UNESCO. Branch in Iran, Tehran, 1984/5)

*Bhaskara II's *Lilavati* (From Japanese translation with commentaries and
notes, helped by Yano Michio& Hayashi Takao)

Al-Kashi's *the Key to Arithmetic* (From Arabic manuscript)

*Seki, Takebe,... *Highlights of Wasan*

(* Completed and to appear in 2006)

(iii) Organization of International Conference

Till moment, the following plan has been proposed by Professor YANO
Michio:

The 2nd International Conference on History of Exact Sciences along the
Silk Road, Kyoto, 2008.